REVIEW OF POST- HARVEST DETERIORATION OF RUBBER SEEDS

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ABSTRACT
Rubber seeds have potential use as a source of industrial oil as well as a protein supplement for use in livestock diets. This has necessitated large-scale collection and storage or rubber seeds for uses other than propagation. Like other traditional Nigerian grains and oilseeds, rubber seeds are prone to post-harvest deterioration. The main causes of deterioration of rubber seeds are excessive moisture, and pests, such as fungi, insects and rodents. To reduce losses, it is imperative that rubber seeds are dried to a moisture level of 7% or less, before storage. Only whole (unshelled) seeds should be considered for long-term bulk storage. Dried, insecticide treated rubber seeds kept in matter polypropylene bags under strict storage hygiene can be effectively stored for at least one year.

Keyword: Rubber seeds, post-harvest, Deterioration, Preservation and Storage.

INTRODUCTION

Annual production of seeds of para rubber (*Hevea brasilensis* Muell Arg.) Nigeria is estimated at 43,000 tones (RRIN, 1985a). This quantity of seeds is largely wasted, as only a fraction is utilized in growing rootstocks for budding. However, studies have shown the potential of rubber seeds as a source of seed oil for industrial use, such as in the manufacture of alkyd resins for the paint industry (Aigbodion, 1991; Nair *et al.*, 1981) and in the formulation of printing ink, glazing putty, dermal fat-liqour, liquid soap and hair shampoo (RRIN, 1989b). The rubber seed oil, especially when refined, has been shown to have promise as a linoleic acid-rich vegetable oil (Gnadhi *et al.*, 1990; Ukhum and Uwatse, 1988). The cake or meal derived from rubber seed after oil extraction is also potentially useable for livestock feeds and diet (RRIN, 1985b). So also is the undefeated rubber seed (Achibewhu, 1986). These findings have necessitated large-scale collection and storage or rubber seeds to ensure regular seeds to ensure regular supply of raw material for industries that may have need for rubber seeds, since rubber seed production is seasonal occurring only once a year in Nigeria (July to October).

For the purpose of this paper, the term 'post-harvest' covers the period between the forcible discharge of rubber seeds from the rubber pods, and the crushing of seeds for industrial use. Much information is available on post-harvest deterioration of traditional Nigerian grains and oilseeds such as maize, groundnut, palm produce, cocoa and kolanuts (Eggins, 1961; Kuku and Adeniji, 1977; Oludemokun and McDonald, 1979). Similar information on rubber seed is lacking. This paper reports on causes of post-harvest deterioration of rubber seeds as well as well ... method of reducing losses from deterioration. Since much of deterioration occurs during storage, strategies for effective bulk storage of rubber seeds as adopted at the rubber Research Institution of Nigerian (RRIN), are highlighted.

Causes of post – harvest deterioration of rubber seeds

Post-harvest operations of rubber seeds include seed collection, transportation, drying, and storage. Improper methods of such operations, as well as inability to effectively control chemical and biological factors during the post-harvest period could result in deterioration in quality of rubber seeds. In Nigeria above operations are usually by picking the seeds indiscriminately irrespective of clonal types from the plantation floor by vendors. Seeds are packed in jute sacks and then transported in trucks or in wheel barrows and sold to the rubber seed factories. Seeds are heat-dried in machines, thereafter are re-bagged in fresh jute bags and stored in warehouses for subsequently uses.

Chemical/Biochemical Factors:

Deterioration of seed quality after harvest may occur as a result of chemical reactions brought about by the activity of enzymes naturally present in seeds. Such dexterous changes in rubber seeds which have been observed after harvest include the increase in free fatty acids (Anon, 1978) and production of hydrocyanic glucoside, linamarin, which the seeds contain (Uzu *et al.*1986; Webster and Baulkwill, 1989). The level of vitamin C (Which is a known antioxidant) may also decrease in stored rubber seeds (Okoye, 1986). In Nigeria, changes leading to deterioration are due to environmental factors such as wet conditions, and if seeds are not prepared adequately for storage, very soon become liable to deterioration.

Role of Moisture:

Rubber seeds are known to have a high moisture content, especially at time of harvest. In Nigeria, moisture content of rubber seeds about one month after seed fall has been reported to be as high as 29.7% at Iyanomo (Otoide and Begho, 1986), and 38% at Itaogholu (Okhuoya and Ige, 1986). In the tropics, 70% is regarded as the minimum relative humidity for the growth of most moulds. The moisture content of grain which is in equilibrium with surrounding air at the grain (Oyeniran, 1980; Vanek and Hoberg, 1992). This varies form grain to grain and has been determined for various Nigerian stored grains (Agboola, 1992; Oyeniran, 1980;). Igeleke (1990) determined the moisture content for deterioration – free storage of rubber seed to be 7% and below. However, poor storage facilities susceptible to moisture exposure abound in Nigeria and account greatly for post harvest deterioration of seeds generally.

Biological Factors:

Pests:

Pests of rubber seeds in Nigeria have been identify as fungi, insects and rodents.

Fungi:

Fungi species associated with pest-harvest deterioration of rubber seeds in Nigeria have been reported (Igeleke and Ekpebor, 1986; Okhuoya and Ige, 1986). They include. *Aspergillus candidus, A. tamaril, Penicillium sp and Rhizopus stolonifer*. Others which have been observed as early colonizers by Igeleke and Ekpebor (1986), being field fungi originating from pre-harvest infection include *Dreachlera (Heininthosporium) sp., Collectotrichum sp.* And *Fusarium, Penicillium* and *Rhizopus* have also been reported on rubber seeds of central African origin (Berjak, 1989).

Types of deterioration caused by fungi on rubber seeds:

Discoloration, Rubber seed kernels are buff or flesh-colored when healthy. Fungi growing on kernels impact their various colours to the seeds (Igeleke and Ekpebor, 1986).

Biochemical change.

Moulds are known to increase free fatty acids (FFA) in stored products through the process or lipolysis. Two of the fungi isolated from rubber seeds by Igeleke and Ekpebor (1986) namely, *Aspergillum flavus* and *A. niger* are known to havelypolytic abilities (Coursey *et al.*, 1963)

Rotting and caking seed meal (Heating, and production of mycotoxins). Heating occurs with improperly dried rubber seeds stored in heaps or in deep layers. It is an evidence of spoilage. Production of mycotoxins, Okoye (1986) reported amounts of the *Mycotoxin aflatoxin* B_2 G_1 and G_2 in stored rubber seeds.

Insects:
Attack by insects is a major problem of stored rubber seeds. *Tribolium*
as have been recorded on fresh rubber seeds (Otiode and Begho, 1986) and also on dried stored seeds (Okoye, 1986). Species of *Tribolium* have been associated with various stored seeds in Nigeria (Agboola, 1992) and other parts of Africa (Mlambo *et al.*, 1992). These insects cause appreciable damage to stored rubber seeds by boring holes in the kernels, after gaining entrance through the micropyle in the hard testa. In serious infestations, the kernels are reduced to powder.

Rodents:
Rodents damage storage bags thus scattering seeds in storage. They also eat up some appreciable quantity of rubber seed kernels after cracking open whole seeds. Rodent are know to transmit dangerous diseases to man. These diseases include plague, typhus, trichinosis, rabies and Lassa fever (Hoppe. 1980, Zehrer, 1980). The control of rodents is therefore imperative.

Pre-storage handling of rubber seeds

Reducing deterioration during early post-harvest operations

Much of rubber seeds deterioration occurs in storage. However, maintenance of proper handling methods in early post harvest operation have been observed at the Rubber Research Institute of Nigeria (RRIN) to greatly reduce deterioration. Some of these methods are considered.

Rubber Seed Collection

Shortly before seed fall, rubber plantations should be clean weeded, and old seeds from previous seed seasons removed from the plantations. This allows for easy collection of fresh, whole seeds (RRIN, 1989a). By collecting seeds once or twice a week, they do not remain on the ground for too long where they are exposes to moisture as well as insect and fungal attack (Aniamaka and Uraih, 1990). Onokpise (1980) observed that rubber seeds harvested in the first and second week of August had the highest weights indicating the presence of greater food reserves. Early August may therefore be the best time to collect seeds for storage.

Transportation

Care should be taken in transporting seeds from the site of collection, in order to ensure that seeds do not become crushed or cracked as this allows fungi to attack easily. Seeds should preferably be transported in bags that allow for aeration, as the seeds are still respiring. If aeration is poor, there could be a build-up of moisture and heat, encouraging growth of microorganisms.

Preparation for storage

As soon seeds have been transported from the field, they should be removed from containers, sorted, spread out and exposed to air, if artificial drying cannot be done immediately. This allows for natural drying and an appreciable drop in moisture content. Otoide and Begho (1986) observed that fresh wholes seeds with initial moisture content of

29.7%, air-dried to a moisture content of 8.4% after a months storage on the floor. If the seeds are several layers thick, they should be occasionally turned over with shovels to expose underlying layers to air.

Measures to control deterioration during storage

Drying

Apart from reducing moisture, drying or heat treatment also halts biochemical processes, which leads to degradation of fats and oils (Ihekoronye and Ngoddy, 1985). Begho, *et al.* (unpublished) observed during a 4-month storage study that there is very little increase in FFA of oil extracted from properly dried rubber seeds. Work in Malaysia (Anon, 1975) and Sri Lanka (Nadarajah ***et al.,*** 1973) have also shown that increase in FFA value of stored rubber seeds can be effectively checked when seeds are heat-treated before storage. Increase in FFA during storage is an important indication of the level of spoilage in oilseeds (Landers and Rathmann, 1981; Okoye, (1986). Drying also greatly reduces the cyanide content of rubber seeds to innocuous levels (Uzu *et al.,* 1986) suggested that merely toasting the kernels in the oven may be sufficient to render them suitable for use as animal feed.

Air-drying is fairly effective only for short-term storage of relatively small quantities of rubber seeds, especially if the seeds are visually free of moulds and insects at the time of collection. For effective long-term storage, it is advisable that rubber seeds are dried to a stage of moisture level of 7% or less. At RRIN, this is achieved be artificial drying, (for 9-12 hrs.) Using heated air (60-70^{0}c) in a batch drier (Figure 1). Drying temperature above 70^{0}c may affect some properties of rubber seeds and the resultant oil. For instance, seeds become brittle and the colour of the seed and oil extracted from it darken (Igeleke, 1990). Length storage also affects colour of extracted oil (Aigbodion, 1994). Batch drier machines are usually employed and the traditional measure of drying the seeds in storage room heated prior to spreading of the seeds on mats on the floor of the room. However, batch drier is a better measure of drying rubber seeds.

Method of storage

After seeds have been dried, they should be allowed to cool before storage. The preferred containers of storage, particularly in bulk storage, are matted polyprophylene bags (Otoide and Begho, 1986). These bags are readily available in the market. The disadvantage of their use is that stored seeds are prone to insect attack. It has been observed that whole seeds (unshelled) store better than kernels (Igeleke and Ekpebor, 1986; Otoide and Begho, 1986). Consequently, only whole clean seeds should be considered for long-term storage.

Storage Hygiene

Dried rubber seeds should be stored in a dry, cool environment, to prevent growth of moulds. This can be done in a properly ventilated warehouse, warehouse, where there are no leakages or floods. At RRIN, rubber seeds in 25kg bags are stored in a warehouse (35 – 40 tonnes capacity). The bags are raised from the floor, on wooden shelves spaced 65cm apart. Bagged seeds are placed on each shelf either vertically, in a single layer, or stacked horizontally, one on top of the other in two layers only (Figure 2). This arrangement allows for enough space for aeration between loaded shelves. Temperatures in the warehouse are kept relatively low (25 – 30^{0}C) by a projecting roof and by ventilation points. Preventive measures against insect infestation include covering ventilation points with insect-proof netting. The warehouse should be cleaned our thoroughly and disinfested before seeds are received for storage. Rats can be excluded from the warehouse by sealing up all openings and cracks, and by ensuring that doors and windows fit well. Piles of rubbish, including old rubber seeds, should be removed from the vicinity of the store, as these attract rodents. Regular cleaning and inspection of the warehouse reduce episodes and levels of pest attack. At the end of the storage season, the warehouse should be thoroughly cleaned out before fresh seeds are again stored. Observance of these measures of storage hygiene, as well as proper pest control, have resulted in successful bulk storage of rubber seeds for at least one year at RRIN

Use of Chemical during storage

Insects could be a serious problem in storage. At RRIN, insects have been successfully controlled in bulk storage by the use of the contact insecticide Actellic (.i.e. 2% primiphos methyl) applied either as dust to the seeds (dosage: 50g/100kg seeds) or as liquid spray to storage shelves and bags containing infested seeds (application: 200ml per 18 litres of water, per 100m^2). The fumigant, hydrogen phosphide, in the form of phostoxin or Gas-Ex-T tablets (i.e. aluminum phosphide) has also been effectively used to control insects (application: one tablet, in an envelope, placed in each 25kg bag of dried rubber seeds). Both pirimiphos methyl and Hydrogen phosphide are among the insecticides recommended for food storage (Agboola, 1992). Laboratory tests at RRIN indicate that treatment with these two chemicals has little or no effect on such properties as acid value, peroxide value, saponification value, iodine value and specific gravity of oil extracted from chemical treated rubber seeds (Begho *et al.,* unpublished data). If ventilation points in the storage, the need for repeated application may not be necessary. Rodents can be kept in check by use of available rodenticides in the market. However, care should be taken to handle rodenticides as most of them are extremely toxic to humans. Rodent control has been achieved by the use of bocks of klerate (i.e. *brodifacoum*). And also by Gas-Ex-T tablets.These tablet are recommended by the manufacturers for use against rats and other rodents as well as insects. The tablet are grand and mixed with food items such as dry fish, and used as bait.

Seed handling practices among farmers in Nigeria

In Nigeria, farmers collect seeds which are traditionally stored in earthenware pots containing sharp sand where they are embedded. The limitation of this practice is that the pots used are small in size to accommodate large quantities of seeds. The natural method of drying the seeds which involves drying the seeds in the sun and free air flow, may take long hours to dry and may be exposed to rain. Generally, seeds collected by farmers may not attain the desirable moisture content before storage and are often prone to insect, mite, fungal and bacterial attack and consequence of it leads to seed deterioration. Improved technology of drying seeds usually involve batch drier machines for large consignment of seeds or any mechanical device using temperature and moving air through the seeds (Okoye, 1986).

Seeds under the traditional method of drying, have short shelf life. For prolonged shelf life, seeds should be collected immediately after seed fall to prevent uptake of moisture, insect or mould activities. Seeds should be dried to safe moisture content of 7% and below capable of reducing the activities of most agents of deterioration. Seeds such as rubber seeds should be bagged in jute sacks before transportation to reduce spillage losses and mechanical damage such as splitting and bruising of seeds. These practices preserve and sustain longer shelf life of seeds for appreciable utilization of seeds.

CONCLUSION

Rubber seeds, like all other oil-rich seeds are prone to deterioration, much of which occurs in storage. The quality of oil extracted from stored rubber seeds is important in the oil-based manufacturing industries (Aigbodion, 1991). Maintaining proper handling methods during post-harvest operations; in particular drying to a safe moisture level, as well as observance of strict storage hygiene, can greatly reduce post-harvest deterioration of rubber seeds meant for industrial use.

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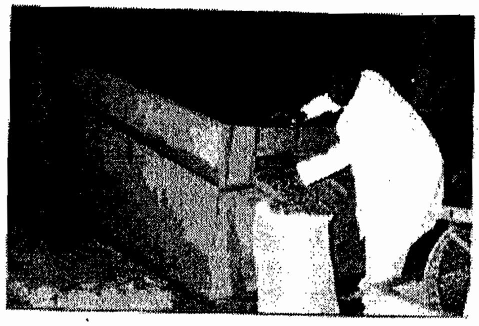

Fig. 1: Dried rubber seeds being removed from the batch drier into a mounted polypropylene bag for storage.